AQ-SPEC

Air Quality Sensor Performance Evaluation Center

Sensor Description

Manufacturer/Model:
Purple Air PA-I

Pollutants:
$PM_{1.0}$, $PM_{2.5}$, PM_{10}

Measurement Range:
0 - 500 µg/m³

Type: Optical

Additional Information

Field evaluation report:
http://www.aqmd.gov/aq-spec/evaluations/field

Lab evaluation report:
http://www.aqmd.gov/aq-spec/evaluations/laboratory

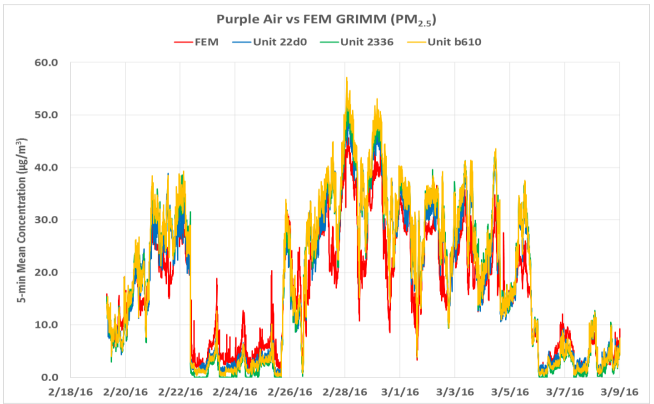
AQ-SPEC website:
http://www.aqmd.gov/aq-spec

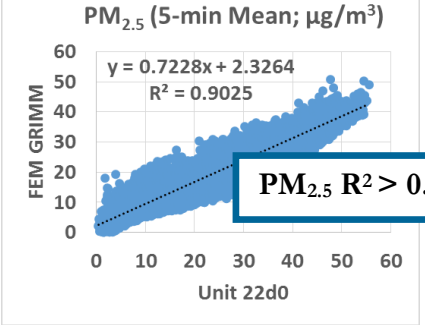
Evaluation Summary

- Overall, the three Purple Air PA-I sensors showed low accuracy, compared to the reference instrument for $PM_{1.0}$, $PM_{2.5}$, and PM_{10}, for a concentration range between 0 to 320 µg/m³.
- The three PA-I sensors exhibited high precision during all tested environmental conditions.
- PA-I sensors showed low intra-model variability as well as good data recovery (99.9%).
- For $PM_{1.0}$ and $PM_{2.5}$, the PA-I sensors had high correlation with the reference instrument from both the field ($PM_{1.0}$ $R^2 > 0.85$, $PM_{2.5}$ $R^2 > 0.90$) and laboratory studies (linear correlation $PM_{1.0}$ $R^2 > 0.95$, $PM_{2.5}$ $R^2 > 0.99$). For PM_{10}, the PA-I sensors did not always follow the concentration change recorded by FEM instrument in the field (PM_{10} $R^2 > 0.39$), however in the laboratory, the PA-I sensors followed the concentration ramping (increasing) change, reporting (PM_{10} $R^2 > 0.97$).

Field Evaluation Highlights

- Deployment period 02/19/2016- 04/19/2016: the three PA-I sensors correlated well the $PM_{1.0}$, $PM_{2.5}$ concentration change as monitored by FEM instrument. PA-I sensors did not always follow the FEM PM_{10} concentration change.
- The units showed 99.9% data recovery as well as low intra-model variability.





$PM_{2.5}$ $R^2 > 0.90$

$PM_{1.0}$ $R^2 > 0.85$

PM_{10} $R^2 > 0.39$

Correlation coefficient (R^2) quantifies how the three sensors followed the ozone concentration change by FEM.

An R^2 approaching the value of 1 reflects a near perfect agreement, whereas a value of 0 indicates a complete lack of correlation.

Laboratory Evaluation Highlights

Accuracy

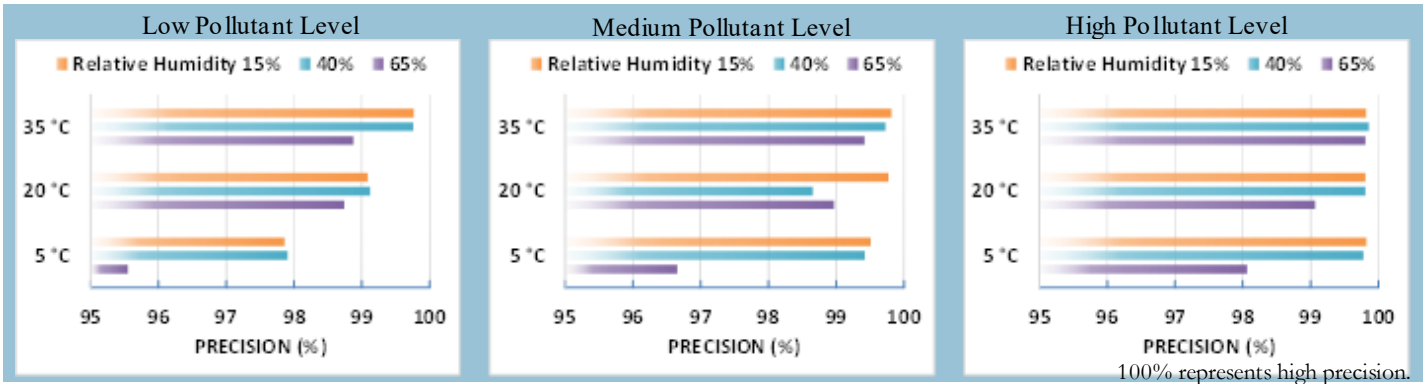
$$A\,(\%) = 100 - \frac{|\bar{X} - \bar{R}|}{\bar{R}} * 100$$

Steady State (#)	Sensor $PM_{2.5}$ ($\mu g/m^3$)	FEM $PM_{2.5}$ ($\mu g/m^3$)	Accuracy (%)
1	43.8	15.9	-74.8
2	96.5	33.4	-88.6
3	187.0	62.4	-99.7
4	505.4	167.6	-101.6
5	796.2	282.6	-81.7
6	866.9	322.1	-69.1

Accuracy was evaluated in a concentration ramping experiment at 20 °C and 40%. The sensor's readings at each ramping steady state were compared to the reference instrument.

Negative % means sensors' overestimation. The higher the positive value (close to 100%), the higher the sensor's accuracy.

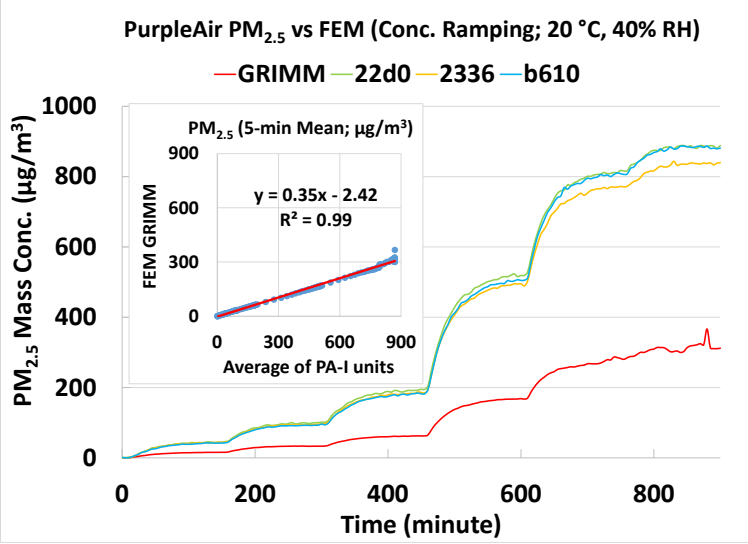
Precision ($PM_{2.5}$)



100% represents high precision.

Sensor's ability of generating precise measurements of PM concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), cold and dry (5 °C and 15%), and hot and dry (35 °C and 15%).

Linear Correlation Coefficient



The three PA-I sensors showed excellent correlation with the corresponding FEM $PM_{2.5}$ data (R^2 = 0.99) at 20 °C and 40% RH.

For conc. ramping experiments of $PM_{1.0}$ and PM_{10}, please see full length lab reports.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the Purple Air PA-I units' precision in most cases. At the set-points of RH changes, PA-I reported spiked changes in concentrations.

Observed Interferents

Not tested for PM sensors